IN THE SPECIFICATION:

Please amend the specification as follows:

Please substitute the paragraph beginning at page 1, line 13, with the following.

-- For measurement of wavefront aberration of a projection optical system, an interferometer may be incorporated into a projection exposure apparatus. However, if such a light source for such an interferometer is provided separately from a light source for the exposure process, it would lead to bulkiness of the exposure apparatus as a whole. --

Please substitute the paragraph beginning at page 4, line 3, with the following.

-- Figure 1 is a schematic view of a projection exposure apparatus according to a first embodiment of the present invention. The projection exposure apparatus of this embodiment is usable for the manufacture of various devices such as, for example, semiconductor devices, liquid crystal devices, image pickup devices and magnetic heads. Also, this projection exposure apparatus can be applied to a step-and-repeat type or step-and-scan type projection exposure apparatus having a resolution not greater than 0.13 micron, for example. --

Please substitute the paragraph beginning at page 4, line 15, and ending on page 5, line 4, with the following.

-- In Figure 1, a continuous emission laser 1 may be an excimer laser, for example, for producing laser light having a center wavelength of 193 nm and a half bandwidth not greater than 0.1 pm. Most of the laser light emitted from the continuous emission laser 1 passes through a

semi-transmission mirror (beam splitter) 51, and it is transformed into incoherent light by means of an incoherency transforming unit for an illumination optical system. Thereafter, the laser light enters the illumination optical system 10. Then, by means of this illumination optical system 10, the laser light is transformed into illumination light having a predetermined sectional shape and having a uniform light intensity distribution, which in turn illuminates a reticle R. --

A3 concld

Please substitute the paragraph beginning at page 5, line 23, and ending on page 6, line 27, with the following.

-- The exposure apparatus has an aberration-free optical system L (including an objective lens, for example), which is another component of the interferometer. For measurement of the wavefront aberration of the projection optical system 3, the aberration-free optical system L is inserted, by means of a driving mechanism (not shown), between a reticle stage 14 for holding the reticle R and a condenser lens of the illumination optical system 10. For exposure of the wafer W, which is the subject to be exposed, on the other hand, the aberration-free optical system L is retracted therefrom. The wavefront aberration of the projection optical system 3 is measured before a reticle R is placed on the stage 14 or, alternatively, after the reticle R is retracted from between the illumination optical system 10 and the projection optical system 3, with the movement of the reticle stage 14. A portion of the laser light reflected by the semi-transmission mirror 51 is reflected by another mirror 11, which constitutes a relay optical system, and additionally, the light is reflected by another semi-transmission mirror 15 and it enters the aberration-free optical system L. The aberration-free optical system L serves to form a light spot

A4

A4 cont'd

(which functions as an object point for the measurement) at an arbitrary object height position (image height position) of the projection optical system 3. Also, after this, the optical system L focuses the laser light from the spot so that it can enter the projection optical system 3. --

Please substitute the paragraph beginning at page 8, line 3, with the following.

A5

-- The thus produced interference fringe is imaged by means of an imaging lens (not shown), upon a photoelectric converter 13. The photoelectric converter 13 converts it into a video signal which, in turn, is applied to an operation unit 8. The operation unit 8 analyzes the video signal, whereby spherical aberration data, which represents the wavefront aberration of the projection optical system 3, is produced. Also, the operation unit 8 may operate to evaluate the state of the projection optical system 3, on the basis of the thus obtained wavefront aberration data. Further, on the basis of the result of <u>the</u> evaluation, the operation unit may perform optimization of the optical performance of the projection optical system 3 automatically, by using an aberration adjusting mechanism of <u>a</u> known type (e.g., a mechanism for moving one or plural lens elements in the optical axis direction), or it may move the wafer stage 4 in the optical axis direction. Alternatively, the operation unit may prohibit the exposure operation. --

Please substitute the paragraph beginning at page 8, line 25, and ending on page 9, line 11, with the following.

-- As regards the interferometer to be provided by the aberration-free optical system L, the projection optical system 3 and the reflection member MR, those well known in the art, that

is, a Fizeau type, a Twyman-Green type, and a Mach-Zehnder type, for example, are preferable. The structure of the aberration-free optical system L may be determined in accordance with the type of interferometer to be used. Fizeau type interferometers are particularly preferably because they are simple in structure. Since continuous emission lasers have a long coherence length, an interference fringe of high contrast can be produced even by a Fizeau type interferometer. --

Please substitute the paragraph beginning at page 9, line 12, with the following.

-- Continuous emission excimer lasers have a tendency that the emission wavelength changes with time. In consideration of ~~it, where~~ this, when a continuous emission excimer laser is used as the continuous emission laser 1, for accurate measurement of the interference fringe, that is, the wavefront aberration, preferably, a wavelength stabilization mechanism to be described later may be provided to stabilize the emission wavelength of the continuous emission laser 1. --

Please substitute the paragraph beginning at page 9, line 22, and ending on page 10, line 1, with the following.

-- The projection optical system 3 may comprise either a dioptric system constituted by a lens system, or a catadioptric system constituted by a combination of plural lenses and a concave mirror. ~~Where~~ When the half bandwidth is small, as in a dioptric system, a lens system being made of a single glass material can be used. --

Please substitute the paragraph beginning at page 10, line 2, and ending on page 11, line 1, with the following.

-- Figure 2 is a schematic view of a projection exposure apparatus according to a second embodiment, which corresponds to a modified form of the projection exposure apparatus of the first embodiment. Unless mentioned specifically, it has similar features as those of the first embodiment shown in Figure 1. The first embodiment shown in Figure 1 uses a semi-transmission mirror 51 to direct a portion of the laser light, outputted from the continuous emission laser 1, toward the aberration-free optical system L. On the other hand, in the second embodiment shown in Figure 2, there is a light path switching mirror 52, which is disposed between the continuous emission laser 1 and the exposure illumination optical system 10. For measurement of the wavefront aberration of the projection optical system 3, by means of the light path switching mirror 52, the ~~while~~ laser light outputted from the continuous emission laser 1 is directed to the aberration-free optical system L. Further, while the first embodiment uses an incoherency transforming element, the second embodiment does not use such an element. However, also in the second embodiment, ~~like~~ as in the first embodiment, an incoherency transforming element may be provided between the light path switching mirror 52 and the illumination optical system 10. --

Please substitute the paragraph beginning at page 11, line 2, with the following.

-- Figure 3 is a schematic view of a projection exposure apparatus according to a third embodiment of the present invention. The projection exposure apparatus of this embodiment is

usable for the manufacture of various devices such as, for example, semiconductor devices, liquid crystal devices, image pickup devices and magnetic heads. This projection exposure apparatus concerns a step-and-scan type exposure apparatus having a resolution not greater than 0.13 micron, for example. Unless mentioned specifically, it has similar features as those of the first embodiment shown in Figure 1. --

[Please substitute the paragraph beginning at page 11, line 15, with the following.]

A5 cont'd

-- Also, in the third embodiment shown in Figure 3, ~~like~~ as in the first embodiment, there are an aberration-free optical system L, a projection optical system 3 and a reflection member MR, which constitute an interferometer. By means of this interferometer, the wavefront aberration of the projection optical system 3 is measured, and adjustment of the same is performed. The beam splitter 51 may be replaced by a switching mirror 52 such as shown in Figure 2. --

[Please substitute the paragraph beginning at page 11, line 25, and ending on page 12, line 13, with the following.]

-- Denoted in Figure 3 at 1 is a continuous emission ArF excimer laser having a center wavelength of 193 nm and a half bandwidth not greater than 0.2 pm, preferably, not greater than 0.1 pm. Denoted at 10 is an illumination optical system for illuminating a reticle R, having a circuit pattern formed thereon, with laser light outputted from the laser 1. Denoted at 3 is a projection optical system for projecting an image of the circuit pattern of the reticle R, onto a

wafer W in a reduced scale. This projection optical system is provided by a lens system being made of a substantially single glass material. Denoted at 4 is a wafer stage, which is movable while holding a wafer W thereon. Fixedly mounted on this wafer stage 4 is a reflection member MR having a spherical mirror. --

Please substitute the paragraph beginning at page 12, line 14, with the following.

-- In the projection exposure apparatus shown in Figure 3, while the reticle is illuminated with slit-like illumination light having a rectangular or an arcuate sectional shape, the reticle R and the wafer W are moved along the widthwise direction of the slit-like illumination light, and mutually in opposite directions. In this manner, the circuit pattern of the reticle R is projected and printed on each shot region of the wafer W. The reticle R and the wafer W are moved at a speed ratio corresponding to the projection magnification of the projection optical system 3. --

Please substitute the paragraph beginning at page 12, line 26, and ending on page 14, line 3, with the following.

-- Denoted in Figure 3 at 5 is a semi-transmission mirror, and denoted at 6 is a wavelength monitor. The wavelength monitor 6 receives a portion of the laser light, reflected by the semi-transmission mirror 5, to detect the wavelength of the laser light. Denoted at 7 is an operation unit, which is operable in response to an output of the wavelength monitor 6, to detect any deviation of the current center wavelength with respect to the design wavelength. Also, the operation unit 7 is operable to actuate a piezoelectric device 9 on the basis of the detected

deviation amount. By means of the operation unit 7 and the piezoelectric device 9, a mirror for resonance of the continuous emission laser 1 can be minutely oscillated in the optical axis direction to change the resonator length, by which the emission wavelength of the continuous emission laser 1 can be controlled to the design wavelength. As a result, the emission wavelength of the laser light can be maintained constant. Here, the resonator length refers to the optical path length between a pair of mirrors provided in the laser light source. With this arrangement, in the projection optical system 3, which is a lens system being made of a substantially single glass material, any variation in optical characteristics such as magnification, focal point position and aberration, for example, due to changes in wavelength of the laser light can be avoided. Therefore, a circuit pattern of a reticle R can be projected onto a wafer W very accurately. --

Please substitute the paragraph beginning at page 14, line 9, with the following.

-- Another operation unit 8 serves to ~~evaluation~~ evaluate a video signal supplied from a photoelectric converter 13 or any other information supplied from other sensors, and also to correct any change in optical characteristic of the projection optical system such as magnification, focal point position and aberration, for example, on the basis of the result of the evaluation. The optical characteristic correction may be carried out, for example, by moving one or more lens elements of the projection optical system 3 or moving the movable stage 4 in the optical axis direction. Alternatively, it may be done in accordance with a method known in the art. --

Please substitute the paragraph beginning at page 16, line 6, with the following.

-- Figure 5 is a block diagram for explaining the structure of the illumination optical system 10 shown in Figure 3. In Figure 5, laser light emitted from the continuous emission excimer laser 1 (Figure 3) is divided by a polarization control system 61 into at least two light beams. If it is ~~bisection~~ bisected, for example, the laser beam may be divided into two light beams having mutually orthogonal polarization directions. A sectional intensity distribution uniforming system ~~2262~~ 62 uses the light beams thus divided, to make the sectional intensity distribution of the laser light uniform. Both ~~of~~ the polarization control system and the sectional intensity distribution uniforming system may be of a known type. Usually, the sectional intensity distribution uniforming system may include at least one of a combination of a fly's eye lens and a condensing optical system, and an optical pipe (kaleidoscope). --

Please substitute the paragraph beginning at page 16, line 26, and ending on page 17, line 22, with the following.

-- Laser light from the sectional intensity distribution uniforming system 62 is focused by a scanning optical system 64 upon a pupil plane of the illumination optical system 10. Then, one or two galvano mirrors of the scanning optical system 64, provided for two-dimensional scanning, are actuated and rotated by a driving unit 63, by which a laser light spot formed on the pupil plane of the illumination optical system 10 is scanningly moved. As a result of this, a secondary light source (effective light source) having a predetermined shape and size is produced on the pupil plane. The thus produced secondary light source may have a circular shape, a ring-

like zone shape having a finite width, or a quadrupole shape, for example. The shape may be chosen automatically or manually in accordance with the type or size of the pattern of the reticle. The laser light from the scanning optical system 64 goes through a masking blade imaging system 65, and it impinges on the reticle (not shown). Consequently, the reticle is illuminated with slit-like light having a rectangular or arcuate sectional shape as described above. --

Please substitute the paragraph beginning at page 22, line 8, with the following.

-- The projection optical system 3 of Figure 6 comprises, in an order from the object side (reticle side), a first lens group L1 having a positive refractive power, a second lens group L2 having a negative refractive power, a third lens group L3 having a positive refractive power, a fourth lens group L4 having a negative refractive power, a fifth lens group L5 having a positive refractive power, a sixth lens group L6 having a negative refractive power, and a seventh lens group L7 having a positive refractive power. It uses seven aspherical surfaces as ~~much~~ such. --

Please substitute the paragraph beginning at page 24, line 13, and ending on page 25, line 9, with the following.

-- The seventh lens group L7 comprises, in an order from the object side, (i) a positive lens of a meniscus shape and having a convex surface facing to the image side, (ii) an aspherical surface positive lens having a biconvex shape, (iii) a positive lens of an approximately flat-convex shape and having a convex surface facing to the object side, (iv) two positive lenses of a meniscus shape and having a convex surface facing to the object side, (v) a negative lens of a

meniscus shape and having a concave surface facing to the image side, and (vi) a positive lens of a meniscus shape and having a convex surface facing to the object side. In this seventh lens group L7, the aspherical surface where an axial light flux, which is a light flux emitted from the axis upon the object surface is used at a higher position, serves mainly to correct a negative spherical aberration to be produced by the seventh lens group that has a strong positive refracting power. Also, the aspherical surface used at the convex surface adjacent to the image plane, is contributable mainly to assure well-balanced correction of the coma and distortion. --

Please substitute the paragraph beginning at page 26, line 15, and ending on page 27, line 17, with the following.

-- Figure 8 is a schematic view of a projection exposure apparatus according to a fourth embodiment of the present invention. In Figure 8, those elements corresponding to the components of the projection exposure apparatus of Figure 3 are denoted by the same reference numerals and characters, and a description ~~therefor~~ thereof is omitted. In the projection exposure apparatus of Figure 8, the output of the wavelength monitor is applied also to an operation unit 8, in addition to the operation unit 7. The operation unit 8 operates on the basis of any variation in output of the wavelength monitor 6 (that is, variation in wavelength of the laser light), in addition to the output of the photoelectric converter 13, and corrects a change in optical characteristic of the projection optical system 3 such as magnification, focal point position and aberration, for example. The correction of optical ~~characteristic~~ characteristics may be made by moving one or plural lenses of the projection optical system 3 or the movable stage 4 in the

optical axis direction, or in accordance with any other method known in the art. With the provision of the function for correcting the optical ~~characteristic~~ characteristics of the projection optical system 3, such as described above, wavelength stabilization through the operation unit 7 and the piezoelectric device 9 and the correction of optical ~~characteristic~~ characteristics can be performed selectively or, alternatively, both may be done. --

A10 cont'd

Please substitute the paragraph beginning at page 28, line 1, with the following.

-- In continuous emission excimer lasers, in some cases, it takes a substantial time until, after a start of the emission, the center wavelength becomes equal to a design value (usually, the same as the wavelength with respect to which an optical system is designed) or alternatively, in worst cases, the emission wavelength does not come to the design value. If, on the other hand, in accordance with the injection locking method, the pulse emission excimer laser light having a center wavelength the same as the design wavelength thereof and having its bandwidth narrowed to 1 pm or less is injected into a continuous emission excimer laser, the emission wavelength of the continuous emission excimer laser can be held at the design wavelength 193 nm thereof, just from the start of the emission. --

A11

Please substitute the paragraph beginning at page 30, line 12, with the following.

-- In this case, the excimer laser 1 may be a continuous emission F2 excimer laer having a center wavelength of 157 nm, and a half bandwidth of 0.1 pm or less, preferably, not greater than 0.08 pm. --

A12

Please substitute the paragraph beginning at page 30, line 16, with the following.

A12 cont'd

-- In accordance with the embodiments of the present invention as described above, bulkiness of an exposure apparatus, which otherwise might result from introduction of an interferometer into the exposure apparatus, can be avoided. --

Please substitute the paragraph beginning at page 30, line 26, and ending on page 31, line 23, with the following.

A13

-- Figure 9 is a flow chart for explaining the procedure of manufacturing various microdevices such as semiconductor chips (e.g., ICs or LSIs), liquid crystal panels, CCDs, thin film magnetic heads or micro-machines, for example. Step 1 is a design process for designing a circuit of a semiconductor device. Step 2 is a process for making a mask on the basis of the circuit pattern design. Step 3 is a process for preparing a wafer by using a material such as silicon. Step 4 is a wafer process which is called a pre-process wherein, by using the thus prepared mask and wafer, a circuit is formed on the wafer in practice, in accordance with lithography. Step 5 subsequent to this is an assembling step which is called a post-process wherein the wafer having been processed at step 5 is formed into semiconductor chips. This step includes an assembling (dicing and bonding) process and a packaging (chip sealing) process. Step 6 is an inspection step wherein an operation check, a durability check, ~~an~~ and so on, for the semiconductor devices produced by step 5, are carried out. With these processes, semiconductor devices are produced, and they are shipped (step 7). --